THE WEATHER AND CIRCULATION OF FEBRUARY 1951

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The temperature regime in the United States during February 1951 underwent a striking transition during the course of the month, as illustrated in figure 1. The first week was marked by one of the worst cold waves of the twentieth century, as temperatures averaged below normal in nearly all sections, with greatest departures (as much as 23° F.) in the lower Mississippi Valley (fig. 1A). Below-freezing temperatures were recorded at all stations except those in extreme southern parts of Florida, California, and Arizona, and a number of all-time low temperature records were broken in Indiana, Kentucky, and Tennessee. During the second week of the month (fig. 1B) temperatures remained below normal in the East but moderated sharply in the West. In some of the Rocky Mountain States average temperatures for the week were more than 25° higher than in the previous week, and daily maximum temperatures reached record levels on February 10. February's third week was marked by unseasonable warmth throughout eastern and northern portions, but temperatures averaged slightly below normal in most of the Southwest (fig. 1C). By the last week of the month temperatures were above normal in all parts

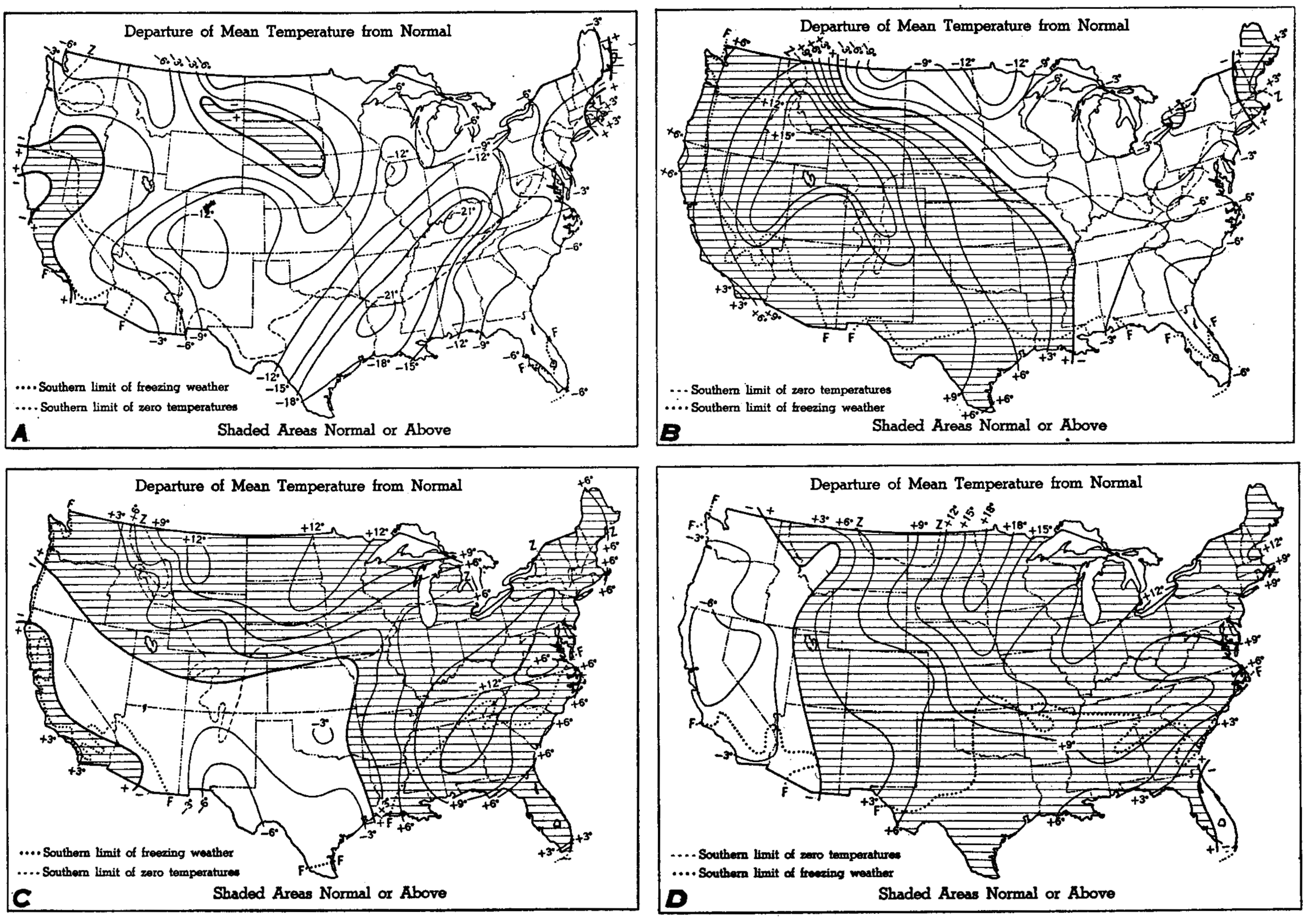


FIGURE 1.—Charts showing departure from normal of the weekly mean temperatures during the month of February 1951; (A) week ending February 6, (B) week ending February 13, (C) week ending February 20, (D) week ending February 27. (Reprinted from Weekly Weather and Crop Bulletin for above dates.)

of the country except the far West (fig. 1D). Thus the temperature regime which prevailed early in February had been completely reversed by the end of the month.

This reversal of the surface temperature pattern was accompanied by an equally striking reversal of the circulation pattern. The mean 700-mb. maps for the first and second halves of February 1951 are presented in figure 2. During the first half of the month a deep full-latitude trough was located in the east-central portion of North America (fig. 2A). This trough was filled with cold polar air carried far southward from strong northerly flow in western Canada and the Arctic Ocean. At the same time the far West was dominated by mild Pacific air transported by strong southwesterly flow off the coast into a well developed ridge in the Great Basin. During the second half of the month, on the other hand, a deep trough was located along the entire Pacific coast of North America (fig. 2B). Strong northwesterly flow between this trough and a well marked eastern Pacific ridge kept temperatures below seasonal normals in the far West. East of the Continental Divide, however, temperatures climbed to well above normal levels as the deep trough of the first half of the month was replaced by a strong ridge. This region was dominated by mild maritime air masses under anticyclonically curved southwesterly flow while strong westerlies in Canada contained the cold polar air. As a result only one polar anticyclone entered the United States from Canada during the second half of February, whereas four anticyclones crossed the border during the first half of the month (Chart IX).[1]

[1] See charts I–XV following p. 44, for analyzed climatological data for the month.

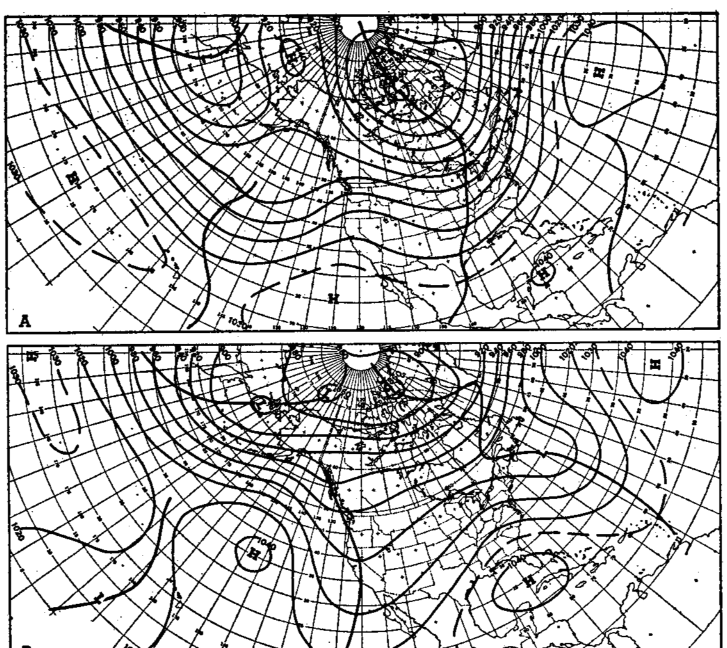


Figure 2.—15-day mean 700-mb. charts for (A) January 30–February 13, and (B) February 14–28, 1951. Contours at 200-ft. intervals are shown by solid lines, selected intermediate contours at 100-ft. intervals by dashed lines, and minimum latitude trough locations by heavy solid lines.

Despite the heterogeneous nature of this February's weather the average temperature and circulation anomalies for the month as a whole are in fairly good agreement. Chart I (inset) shows that surface temperatures averaged above normal in most of the country but slightly below normal in limited areas of the South and West. Correspondingly, figure 3 shows that monthly mean 700-mb. heights were above normal in all parts of the United States except in the far West. Moreover, the mean geostrophic air flow relative to normal was from a southerly direction in most of the country at both 700 mb. (fig. 3) and sea level (Chart XI inset). This flow was easterly, however, along the entire eastern seaboard. Since the land is normally colder than the ocean in this area in winter, this transport of excessive maritime Atlantic air was responsible in part for surface temperatures averaging above normal in the East. The maximum temperature anomaly, more than 6° F., was observed in New England, where the positive 700-mb. height anomaly was greatest and the air flow, relative to normal, from the southeast. On the other hand, temperatures were below normal in Florida and southern portions of Georgia and South Carolina, where winds were northeasterly relative to normal and the severe cold at the beginning of the period had an undue effect on the mean temperature for the month. It is likely that the early period cold was also responsible for the small areas of below normal temperature observed in parts of Texas, Oklahoma, Louisiana, and Arkansas. Below normal temperatures in central California were associated with below normal heights at 700 mb., while below normal temperatures in parts of the southern Plateau were accompanied by greater than normal pressure at sea level. In no part of the Southwest, however, did either the surface temperature or the 700-mb. height depart appreciably from the seasonal normal. Outside of New England the largest positive temperature departures from normal occurred in the Great Plains, where the warm weather was closely associated with a trough just east of the Divide, and below normal pressures at sea level (Chart XI and inset).

The tracks of anticyclones and cyclones shown in Charts IX and X present a confusing appearance because of the nonhomogeneous manner in which this month's mean circulation was made up. Their interpretation is facilitated by reference to figure 4, which shows the vertical component of the monthly mean geostrophic vorticity at 700 mb. relative to the earth's surface. Values were computed from the circulation around standard intersections of latitude and longitude given by the 700-mb. contour field in figure 3. Comparison of figure 4 with figure 3 and Chart XI reveals that a close connection existed in February between the field of relative vorticity at 700 mb. and the curvature of both the contours at 700 mb. and the isobars at sea level. A similar relation was noted during January 1951 (see article on the Weather and Circulation in January 1951 Monthly Weather Review). During both months several cells of high and low pressure at sea level which appeared merely as open waves in the 700-mb. contour pattern regained their cellular character when the field of relative vorticity at 700 mb. was analyzed. Since most of these vortices showed little horizontal displacement with increasing elevation, the field of relative vorticity at 700 mb. may prove to be a useful index of the sea level circulation, at least for monthly means.

The anticyclone tracks (Chart IX) are clustered in regions where anticyclonic vorticity at 700 mb. was superimposed on high pressure at sea level, namely, the northeast and southeast Pacific, northwest Canada, southeast United States, and the central Atlantic (and the Great Basin to a lesser extent). In these areas anticyclones tended to stagnate and intensify but cyclones were relatively infrequent (Chart X). On the other hand, the conspicuous absence of anticyclones near Bermuda and near the west coast, where they normally abound, was related to the presence on the mean charts of cyclonic vorticity in the troughs at 700 mb. and sea level. This distribution of cyclones and anticyclones can be cited to explain the marked deficiency of precipitation observed throughout the southeast United States in February. In much of this section less than half of the normal precipitation (Chart III–B) and less than one inch of snow (Chart IV) fell during the month while sunshine (Chart VII–B) and solar radiation (Chart VIII inset) were both excessive. However, a corresponding deficiency of cloudiness (Chart VI–B) was not observed, probably because of the abundance of high clouds on the periphery of cyclonic disturbances passing northwest of the area. It is interesting to note that snowfall was excessive in parts of Louisiana, Mississippi, Tennessee, and Kentucky (Chart V–A) despite subnormal precipitation because of early period storminess.

Chart X shows that cyclones were frequent in the Bering Sea, Great Plains, Hudson Bay, Baffin Bay, Denmark Strait, Labrador, and off the east and west coasts of North America. Each of these seats of cyclonic activity was characterized by the presence of cyclonic vorticity at 700 mb. and low pressure or troughs at sea level. The cyclone tracks between these centers generally followed the mean 700-mb. steering flow along the

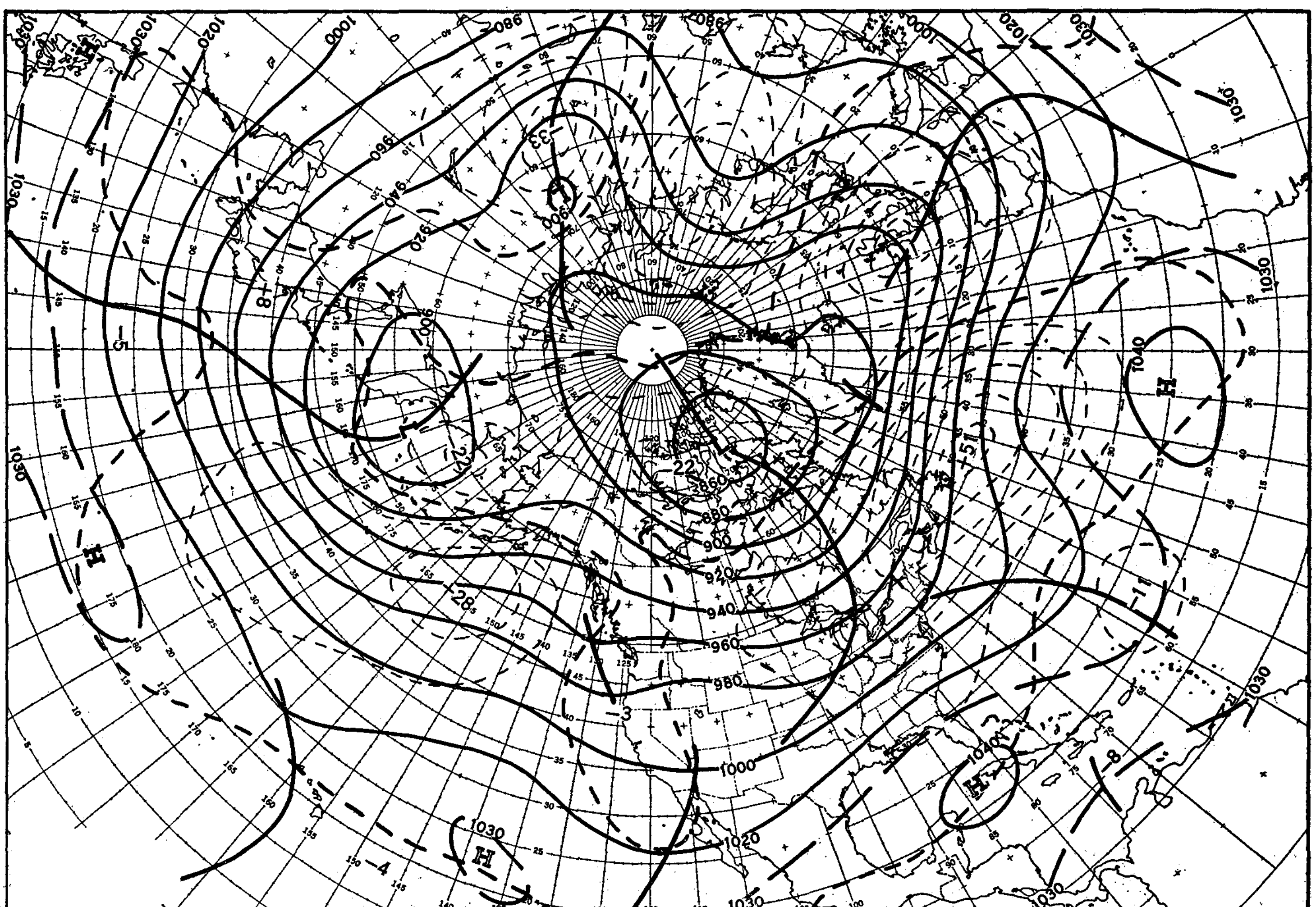


Figure 3.—Mean 700-mb. chart for the 30-day period January 30–February 28, 1951, inclusive. Contours at 200-ft. intervals are shown by solid lines, intermediate contours by lines with long dashes, and 700-mb. height departure from normal at 100-ft. intervals by lines with short dashes with the zero isopleth heavier. Anomaly centers and contours are labeled in tens of feet. Minimum latitude trough locations are shown by heavy solid lines.

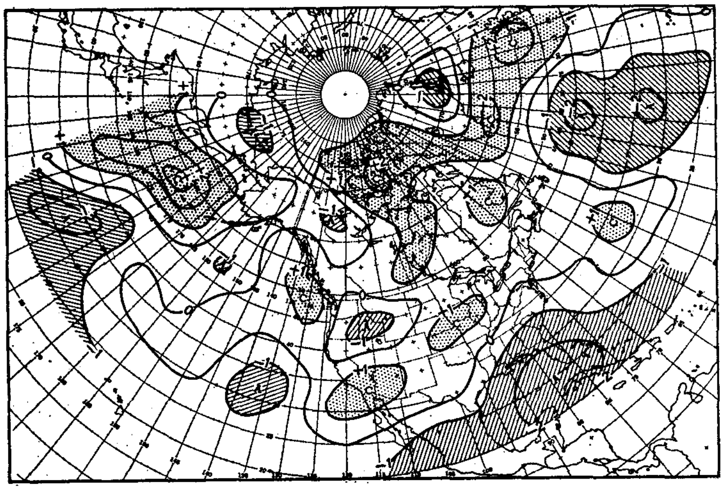


FIGURE 4.—Vertical component of mean relative geostrophic vorticity at 700 mb. for the 30-day period January 30-February 28, 1951. Areas with cyclonic vorticity in excess of 1×10^{-5} per second are stippled and labeled C at the center; areas with anticyclonic vorticity less than -1×10^{-5} per second are cross hatched and labeled A at the center.

axes of cyclonic vorticity at 700-mb. and the troughs of sea level pressure. For example, cyclones approached British Columbia from either the southwest or the northwest, but not from the west where a center of anticyclonic vorticity was located. Likewise, cyclones traversed the United States along either the northern border or from Nevada and the Panhandle northeastward to the Lakes, but none crossed the southeast or northern plateau where anticyclonic vorticity at 700 mb. and high pressure at sea level prevailed.

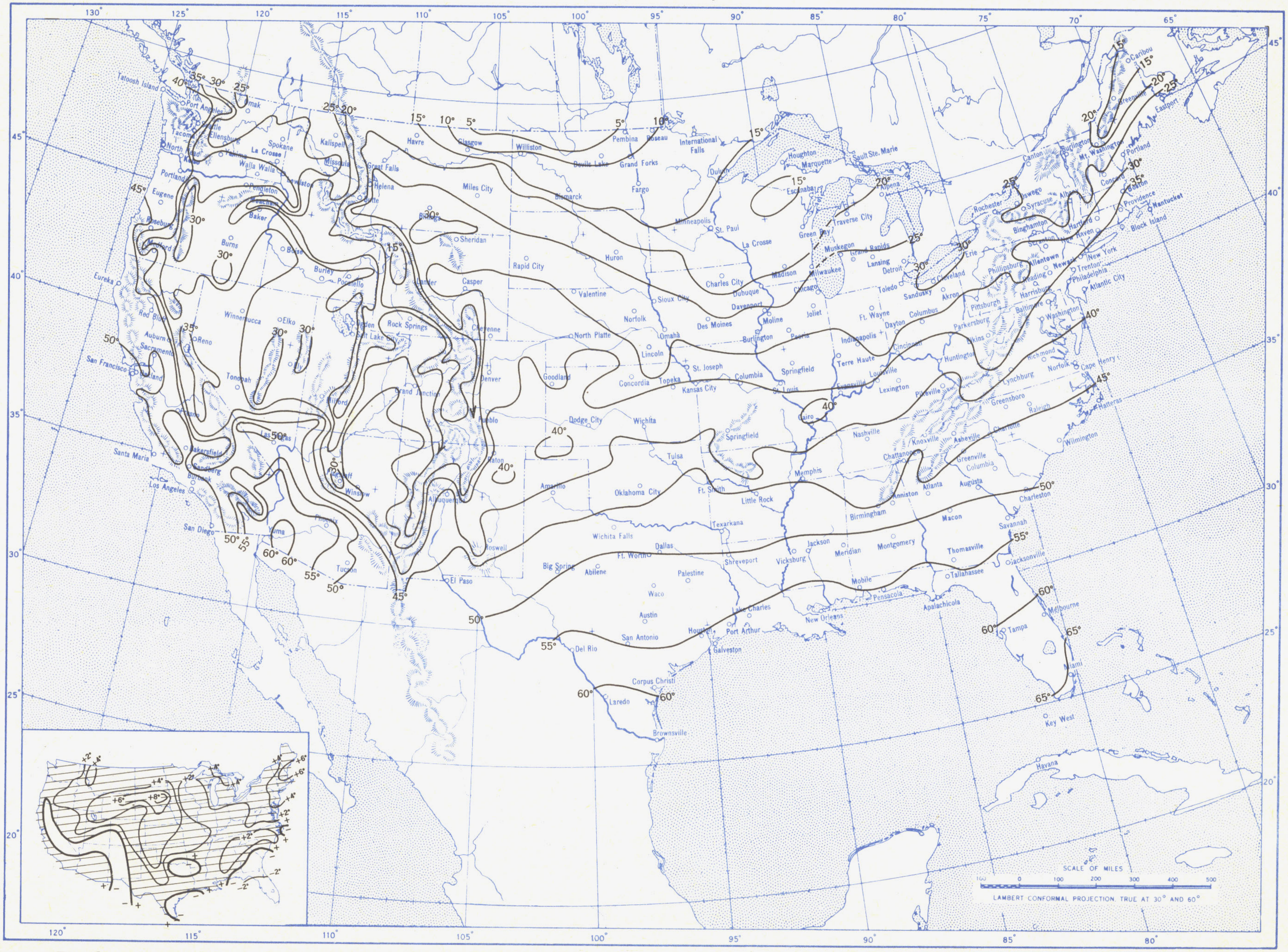
Precipitation was generally excessive in the areas of frequent cyclone activity in the Great Plains, Midwest, Northeast, and along the northern border (Chart III). Likewise, in these sections cloudiness averaged mostly above normal (Chart VI–B) and sunshine (Chart VII–B) and solar radiation (Chart VIII inset) below normal. In much of this area, however, snowfall was deficient (Chart V–A) since surface temperatures were above normal (Chart I inset). This unseasonable warmth, particularly at the end of the month, was responsible for the fact that all but mountain and northern border areas of the country were free of snow cover on February 27 (Chart V–B), despite the fact that appreciable snow had fallen during the month (Chart IV).

The principal regions of deficient precipitation, in addition to the Southeast, were the Southwest, where a center of above-normal sea level pressure was located (Chart XI inset), and the area adjacent to the Black Hills of South Dakota, where relative vorticity at 700 mb. was anticyclonic (fig. 4). No measurable precipitation at all was recorded in some of these sections (Chart II), and snowfall was generally subnormal (Chart V–A) and sunshine excessive (Chart VII–B). Cloudiness, however, generally averaged above normal (Chart VI–B) and was probably either scattered or of the high thin type.

The heterogeneous nature of February's weather was reflected in the fact that the observed 700-mb. mean map for the month as a whole contains four separate and weak trough segments in the vicinity of North America (fig. 3). Elsewhere, the mean circulation was simpler and more sharply delineated. The largest 700-mb. height anomaly anywhere in the Northern Hemisphere was located just southeast of Newfoundland, where mean heights were 510 feet above normal. Persistence of positive anomalies at both 700 mb. and sea level in this region since November 1950 augmented the flow of maritime Atlantic air and produced an extremely warm, wet winter in the Northeast*. These conditions were accompanied by typical blocking action during the latter half of February, as described by Miller and Vederman in the following article. Downstream from the blocking ridge a wave train of large amplitude existed in Eurasia. In this connection it is noteworthy that a center of cyclonic vorticity and below normal heights was located just west of the British Isles, where 700-mb. heights have been below normal every month since July 1950.

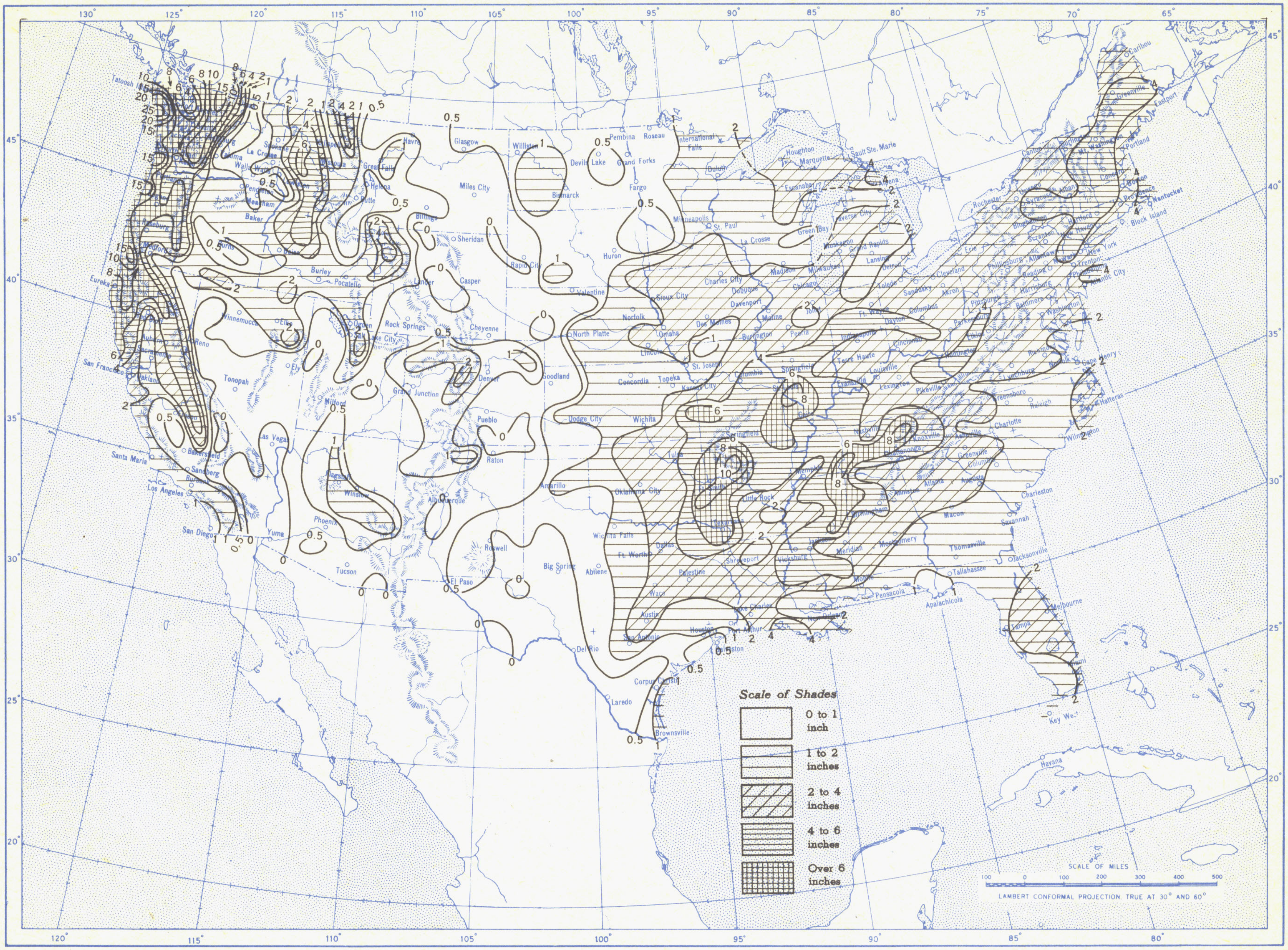
* For further discussion see "The Weather and Circulation of the Winter of 1950–51," William H. Klein, *Weatherwise*, vol. 4, No. 2, April 1951, pp. 38–39, 46.

Chart I. Average Temperature (°F.) at Surface, February 1951. Inset: Departure of Average Temperature from Normal (°F.), February 1951.



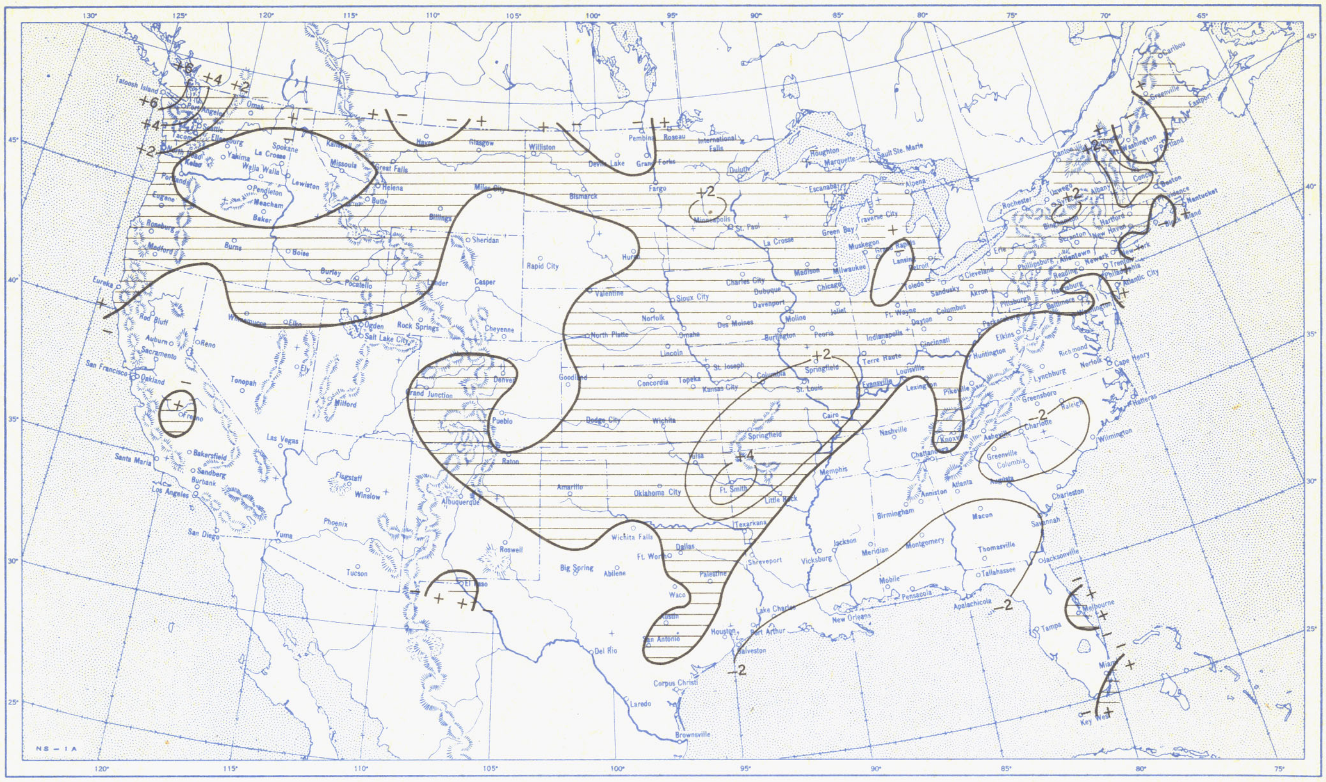
Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), February 1951.

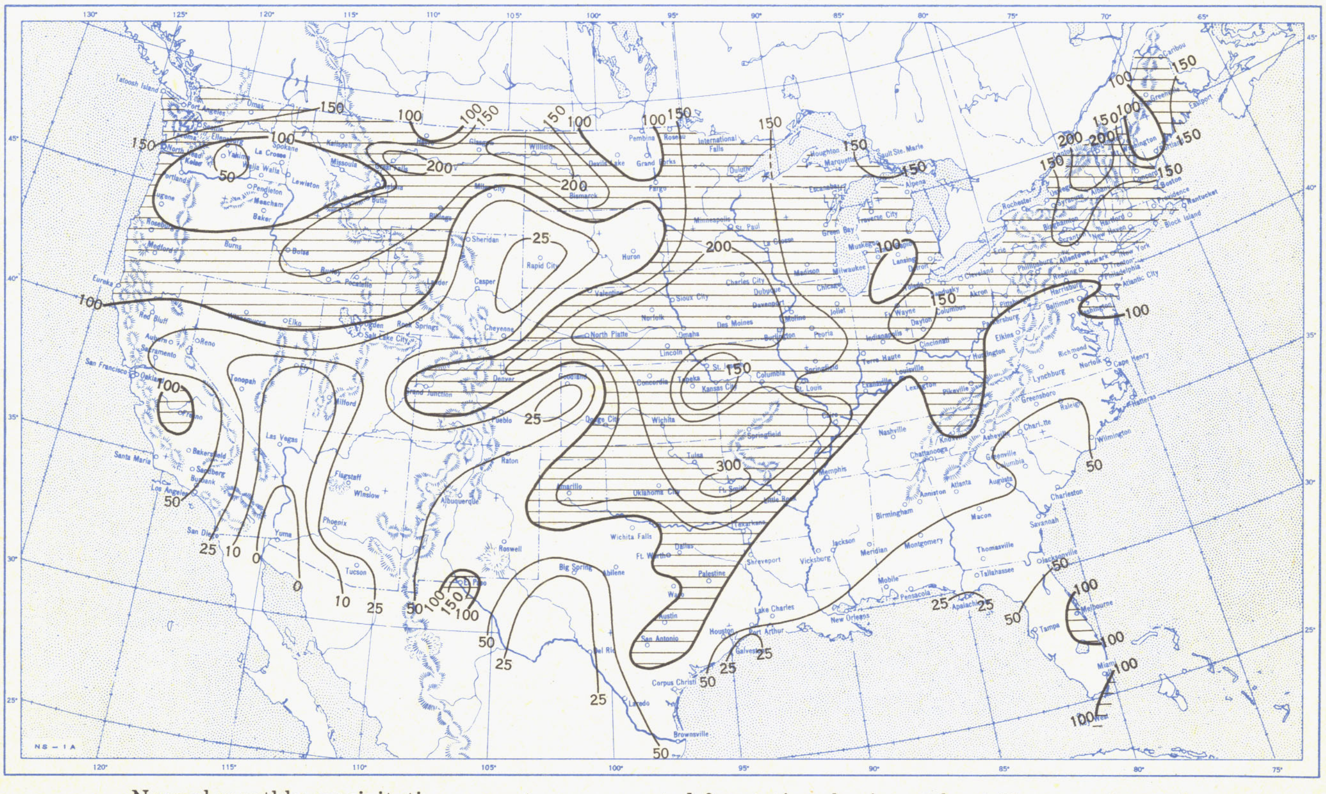


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), February 1951.

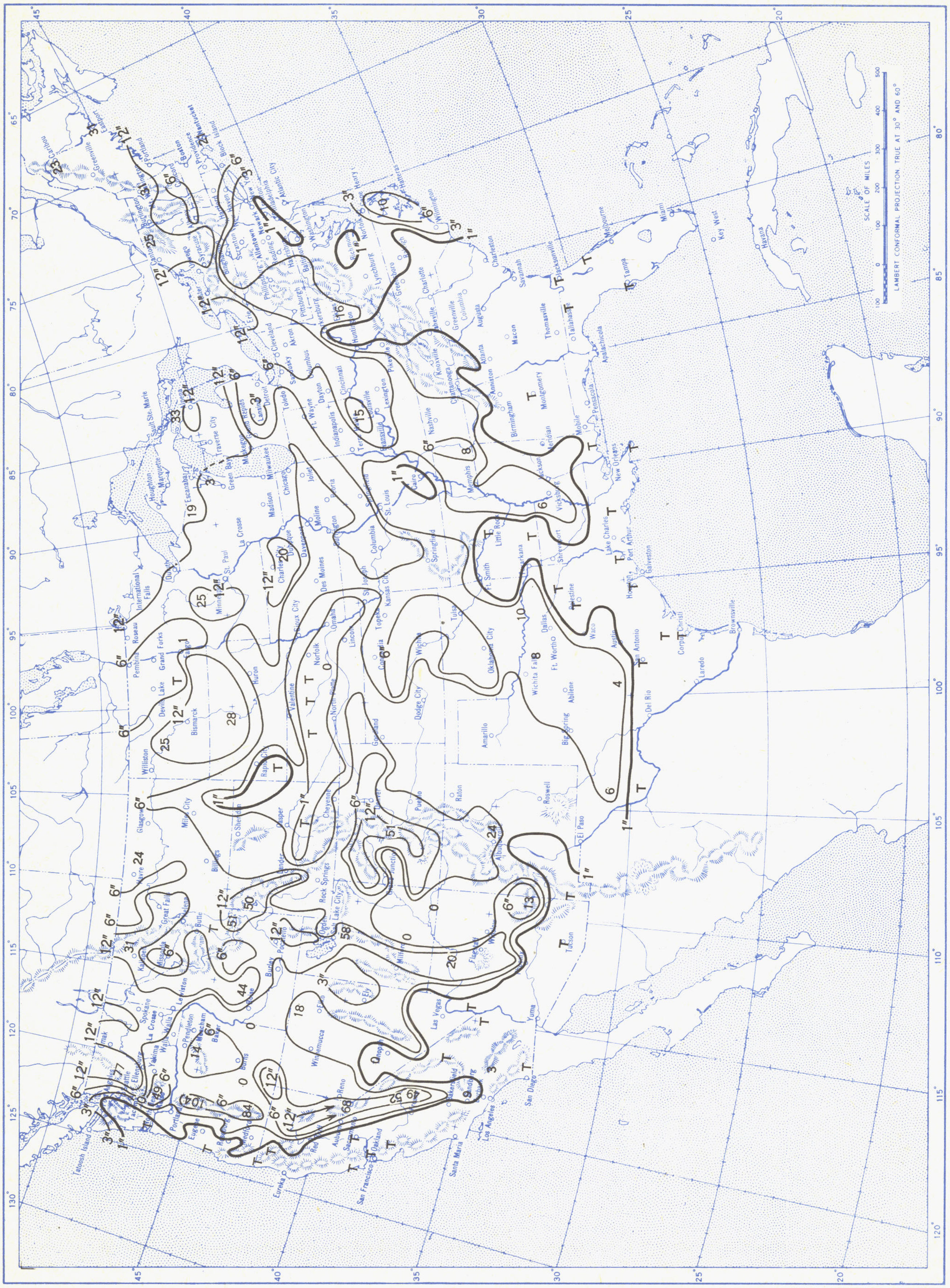


B. Percentage of Normal Precipitation, February 1951.



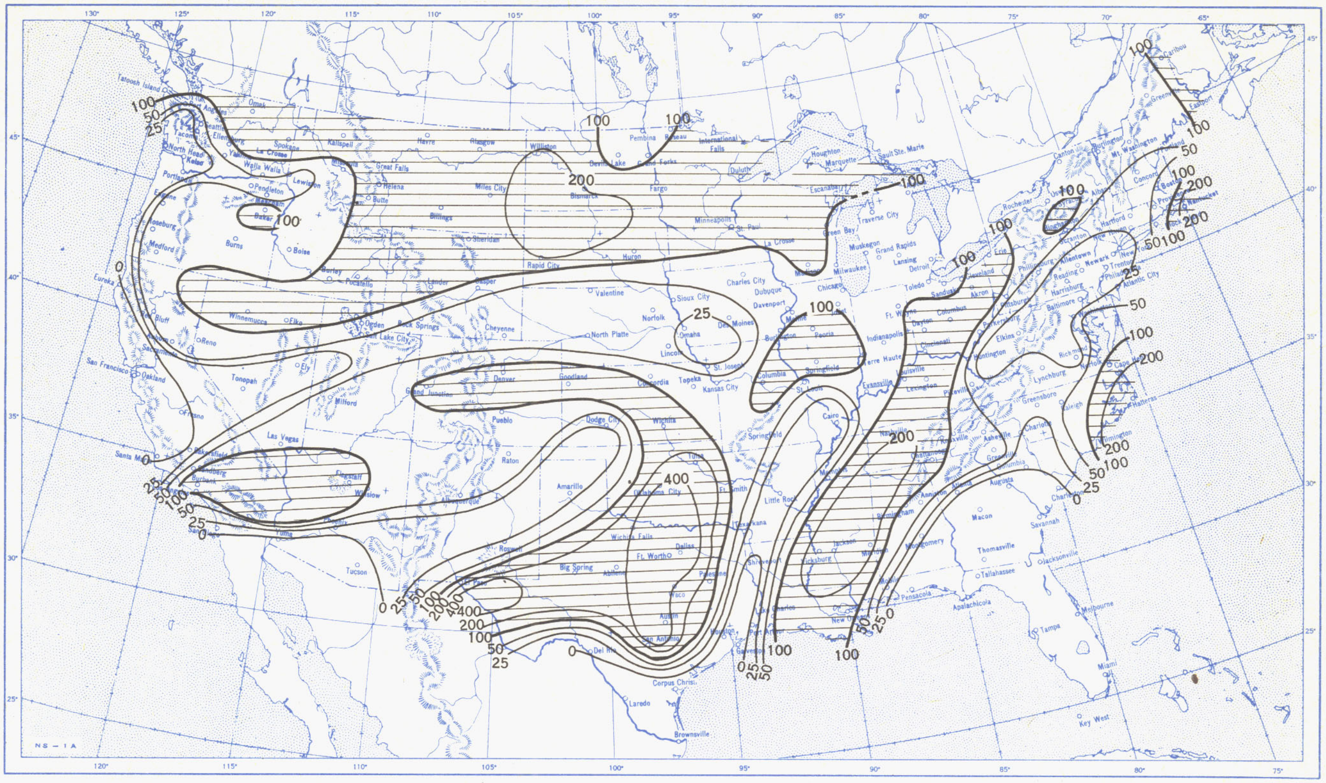
Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart IV. Total Snowfall (Inches), February 1951.

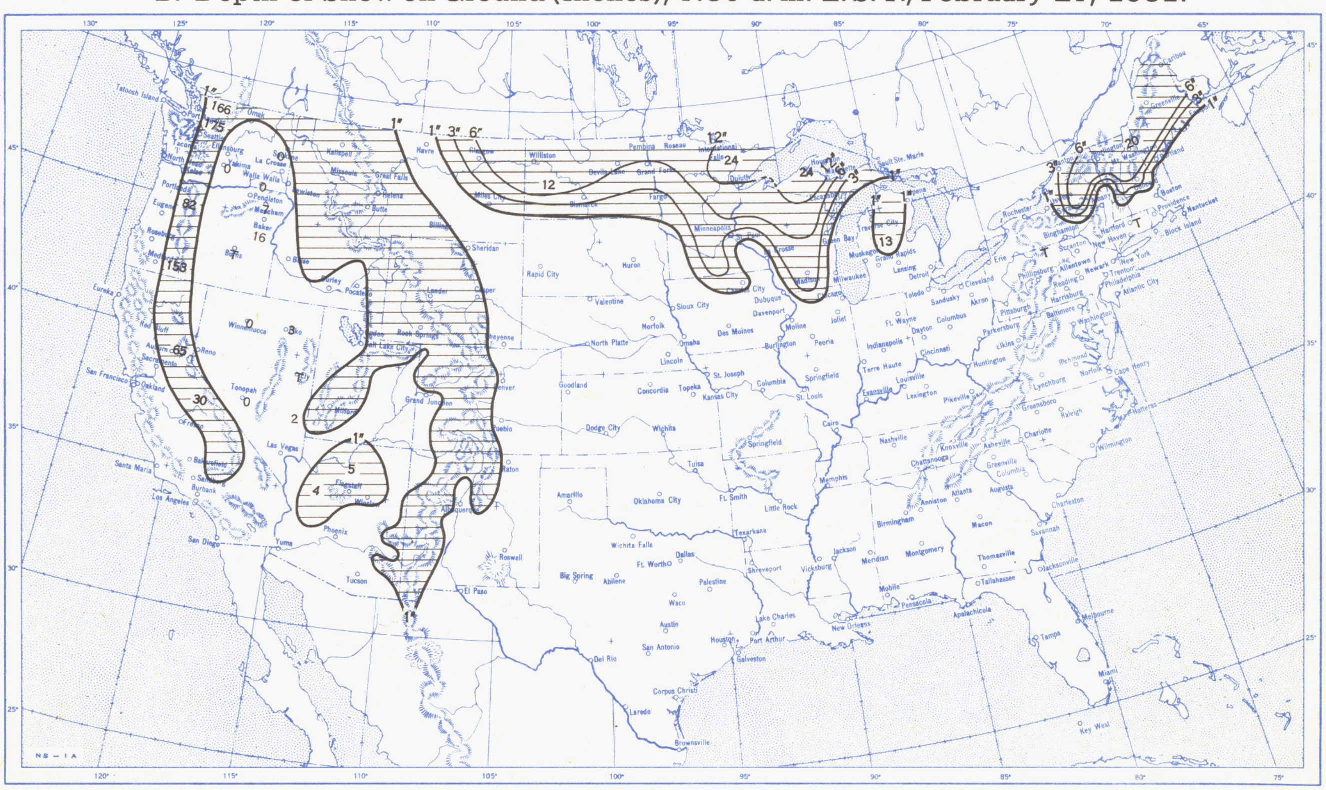


This is the total of unmelted snowfall recorded during the month at Weather Bureau and cooperative stations. This chart and Chart V are published only for the months of November through April although of course there is some snow at higher elevations, particularly in the far West, earlier and later in the year.

Chart V. A. Percentage of Normal Snowfall, February 1951.

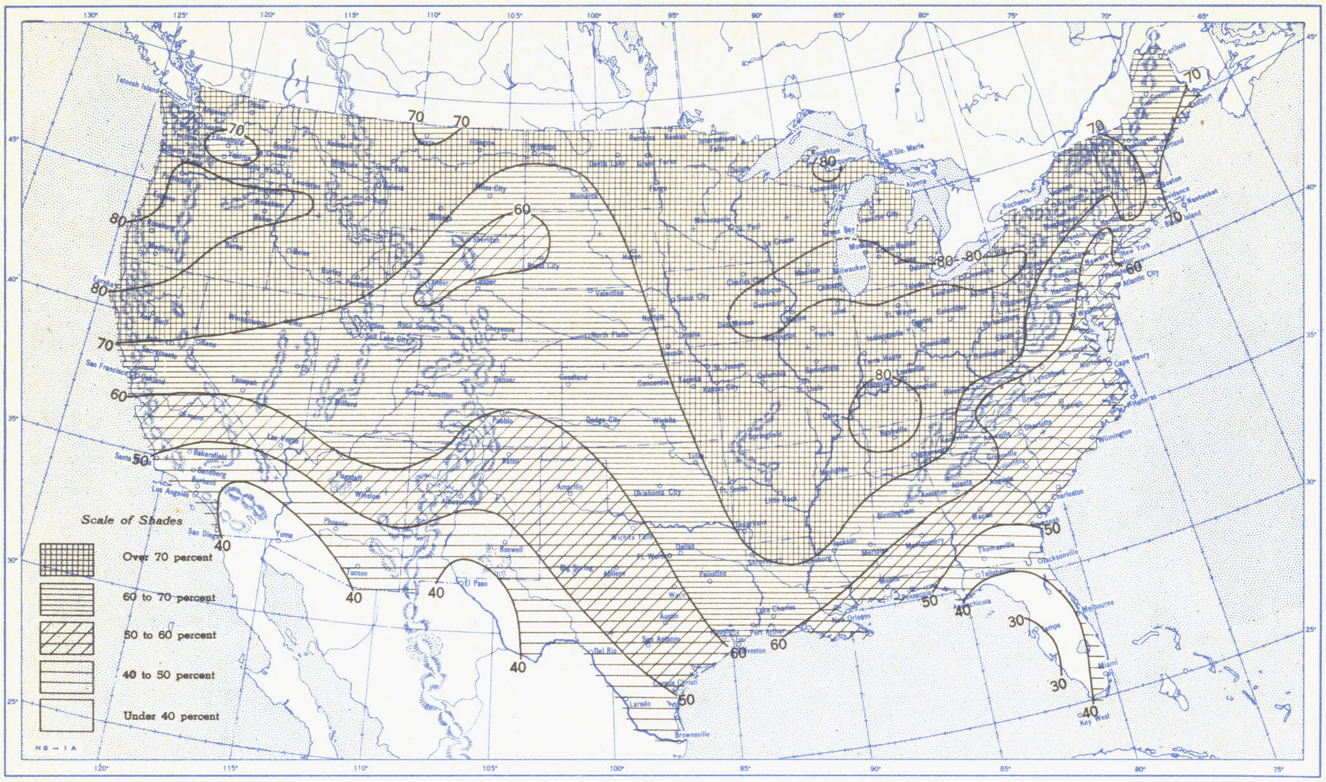


B. Depth of Snow on Ground (Inches), 7:30 a. m. E. S. T., February 27, 1951.

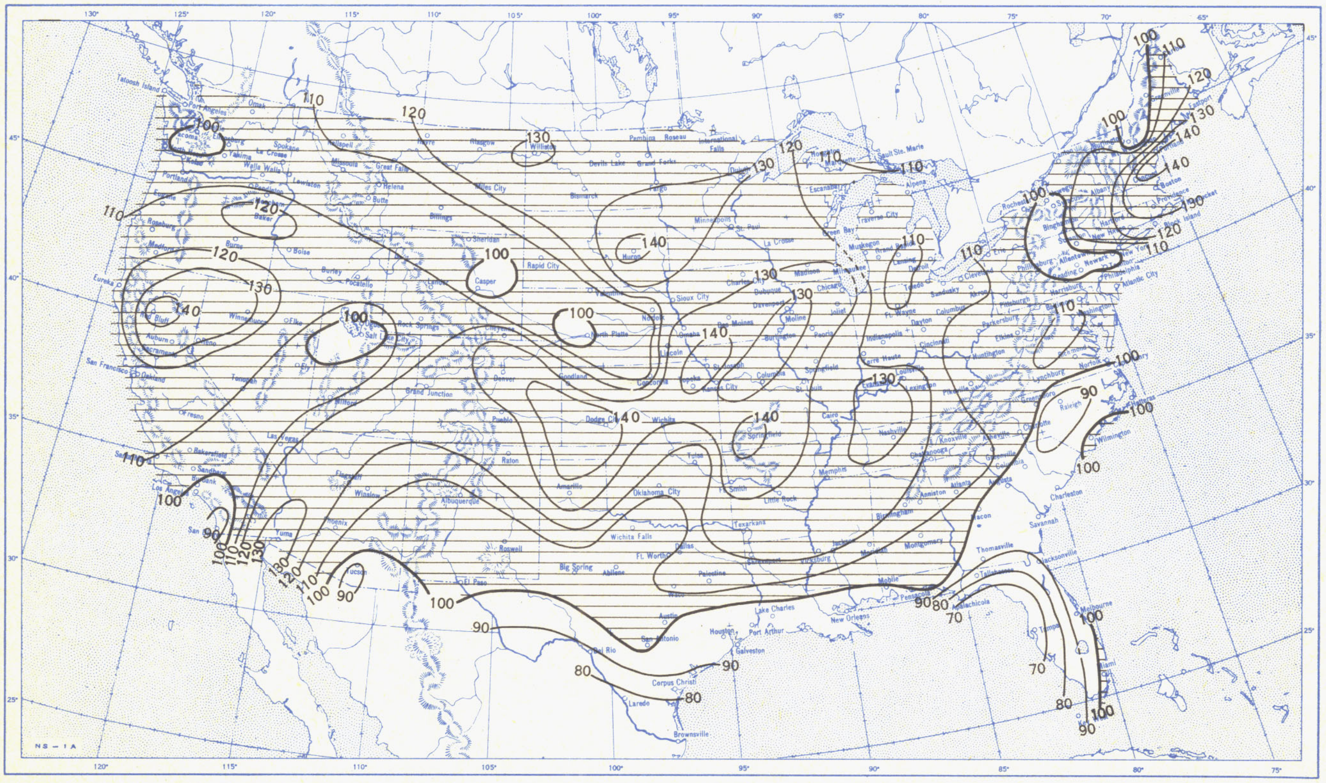


A. Amount of normal monthly snowfall is computed for Weather Bureau stations having at least 10 years of record.
B. Shows depth currently on ground at 7:30 a. m. E. S. T., of the Tuesday nearest the end of the month. It is based on reports from Weather Bureau and cooperative stations. Dashed line shows greatest southern extent of snowcover during month.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, February 1951.

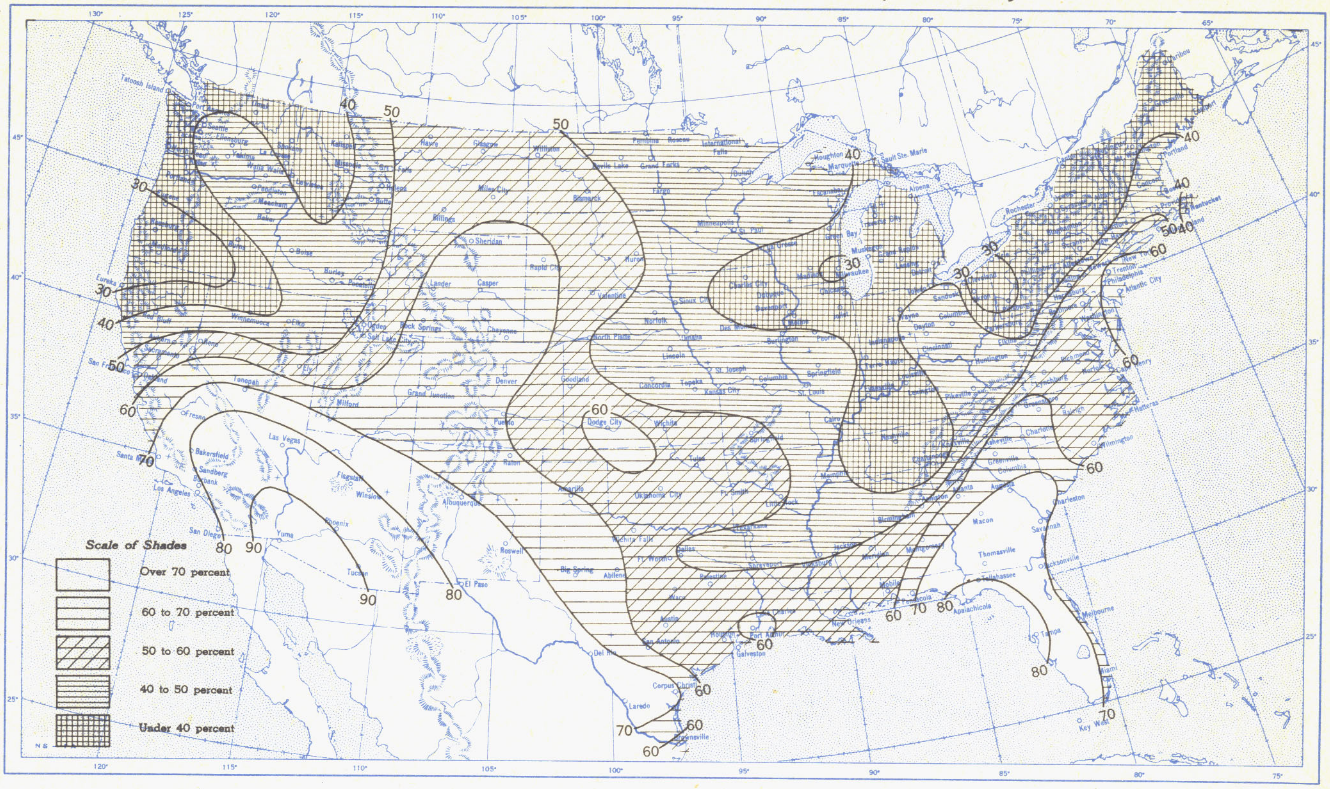


B. Percentage of Normal Sky Cover between Sunrise and Sunset, February 1951.

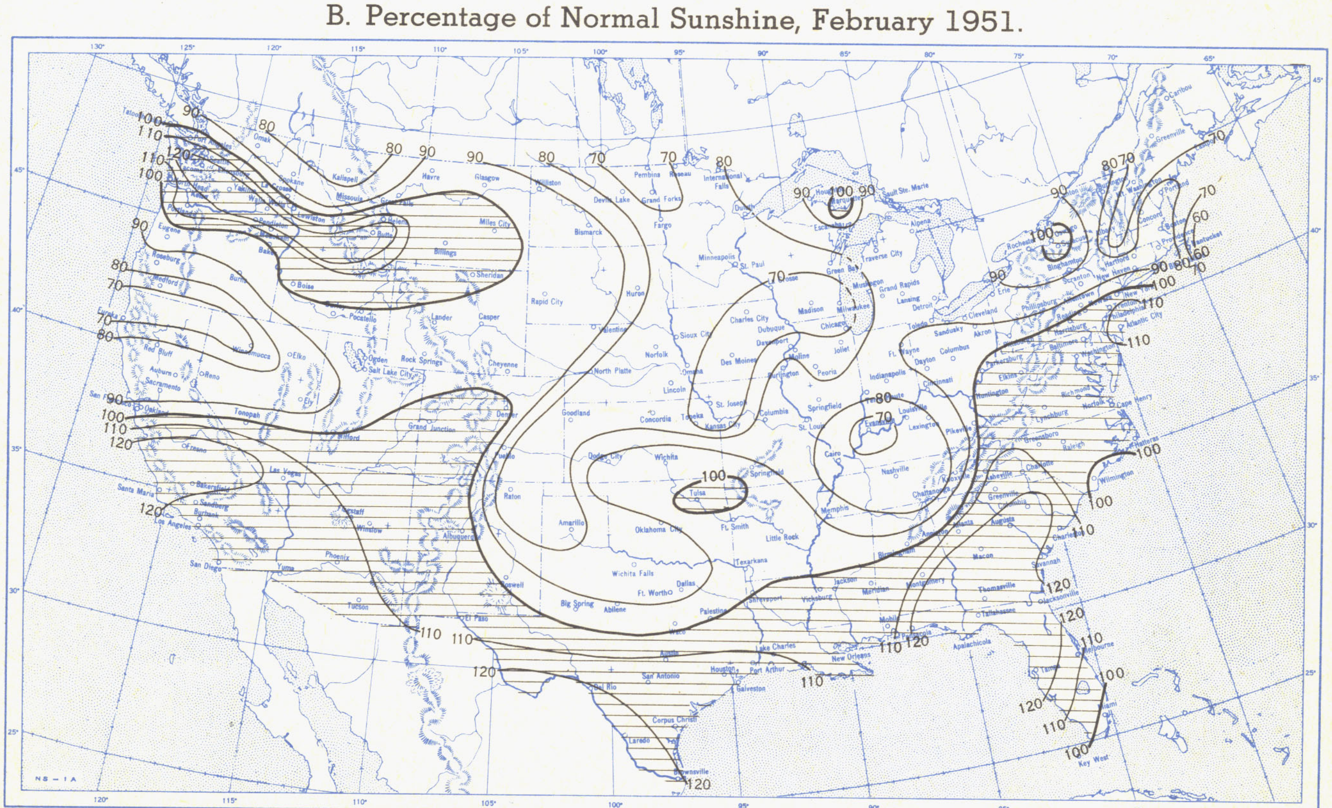


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, February 1951.



B. Percentage of Normal Sunshine, February 1951.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, February 1951. Inset: Percentage of Normal Average Daily Solar Radiation, February 1951.

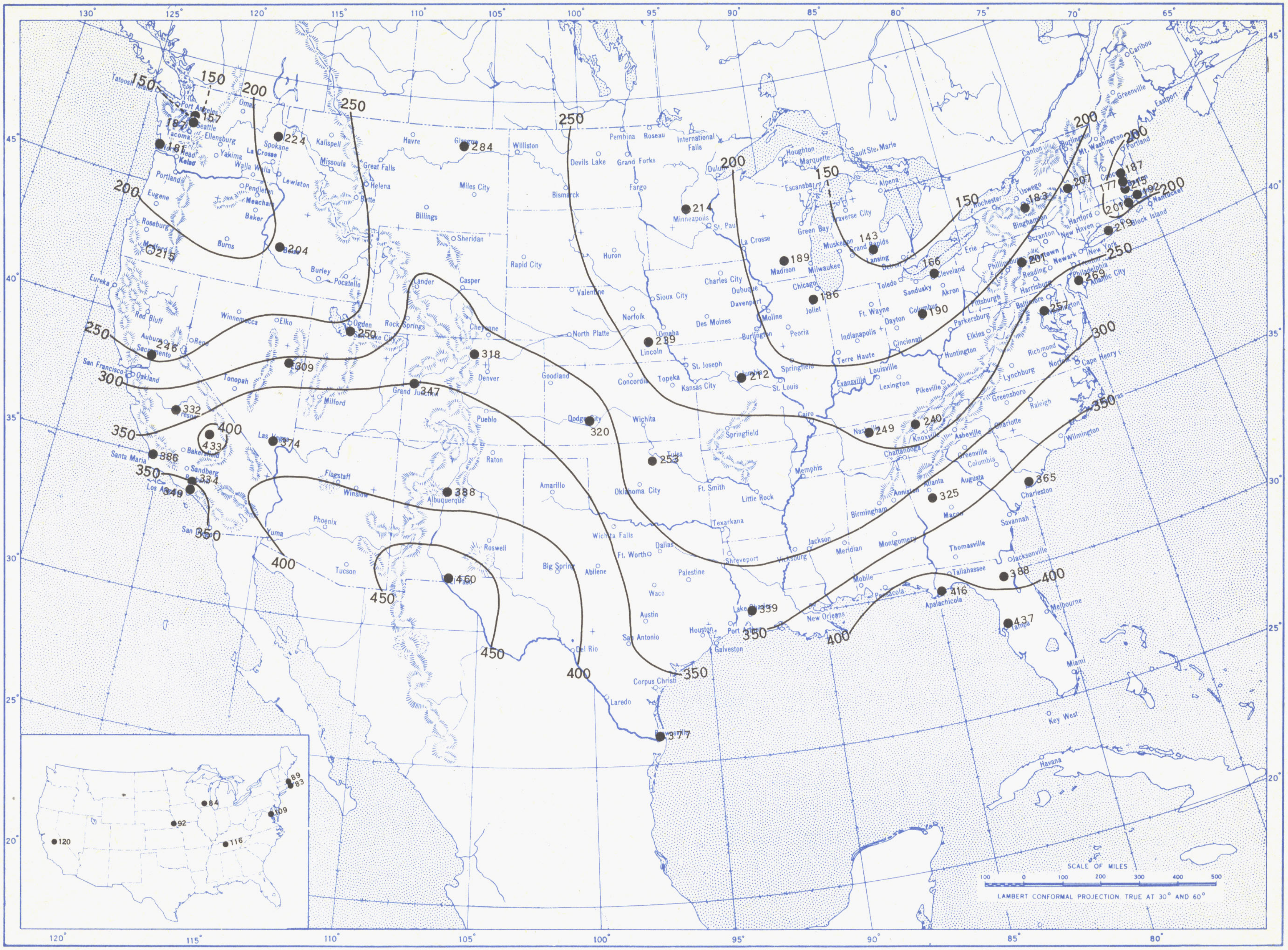
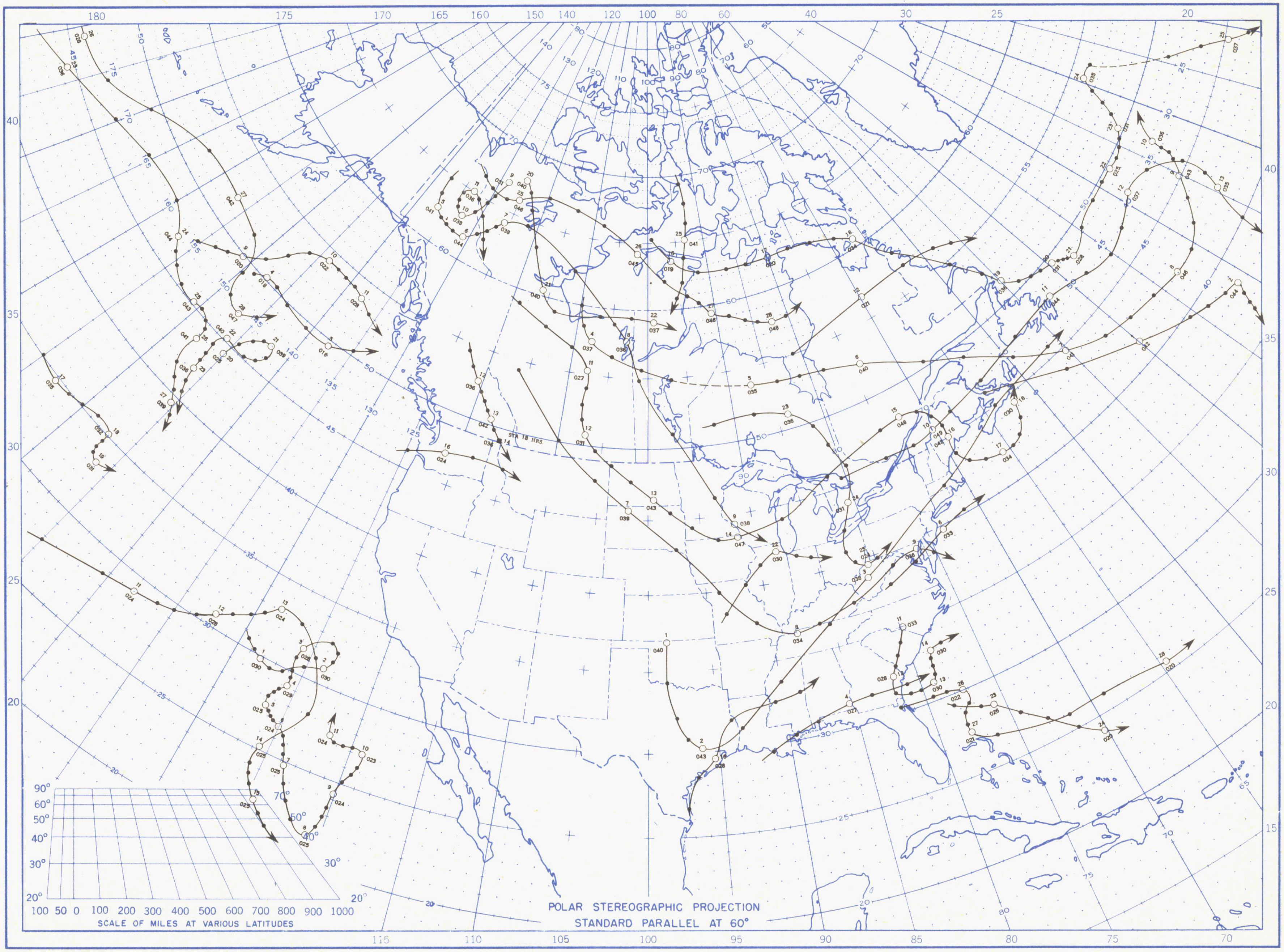


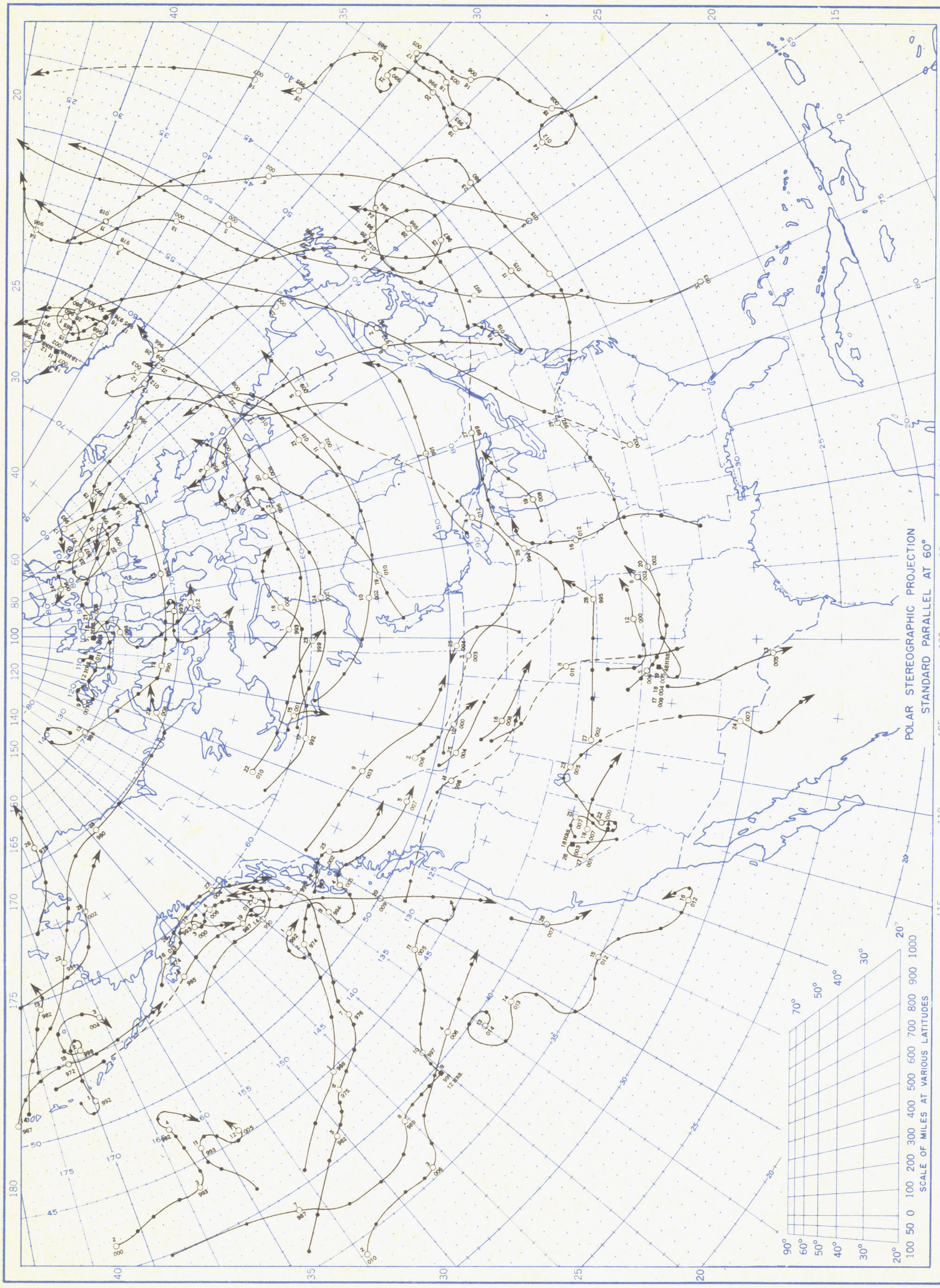
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.$^{-2}$). Basic data for isolines are shown on chart. Further estimates obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, February 1951



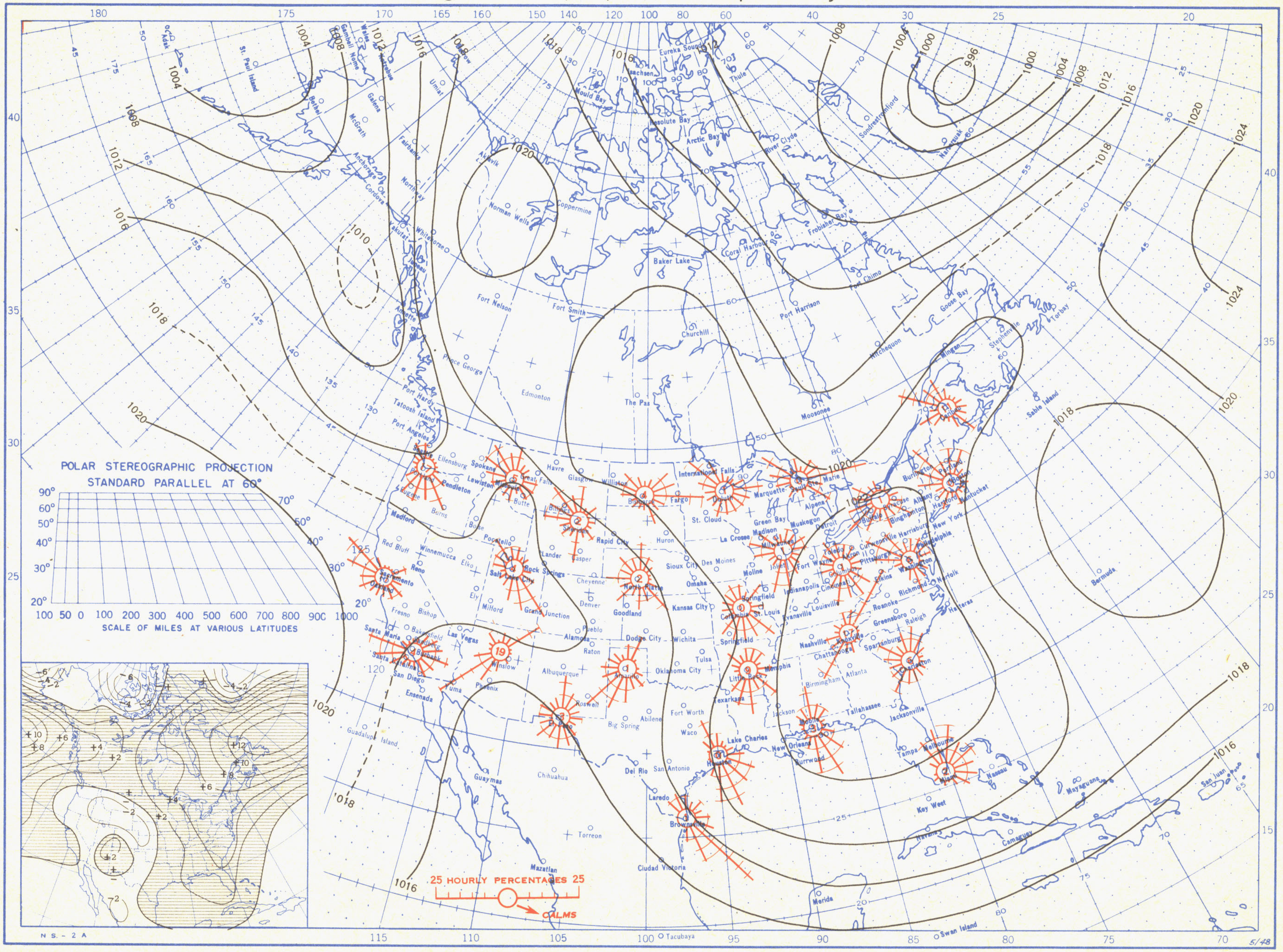
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, February, 1951.



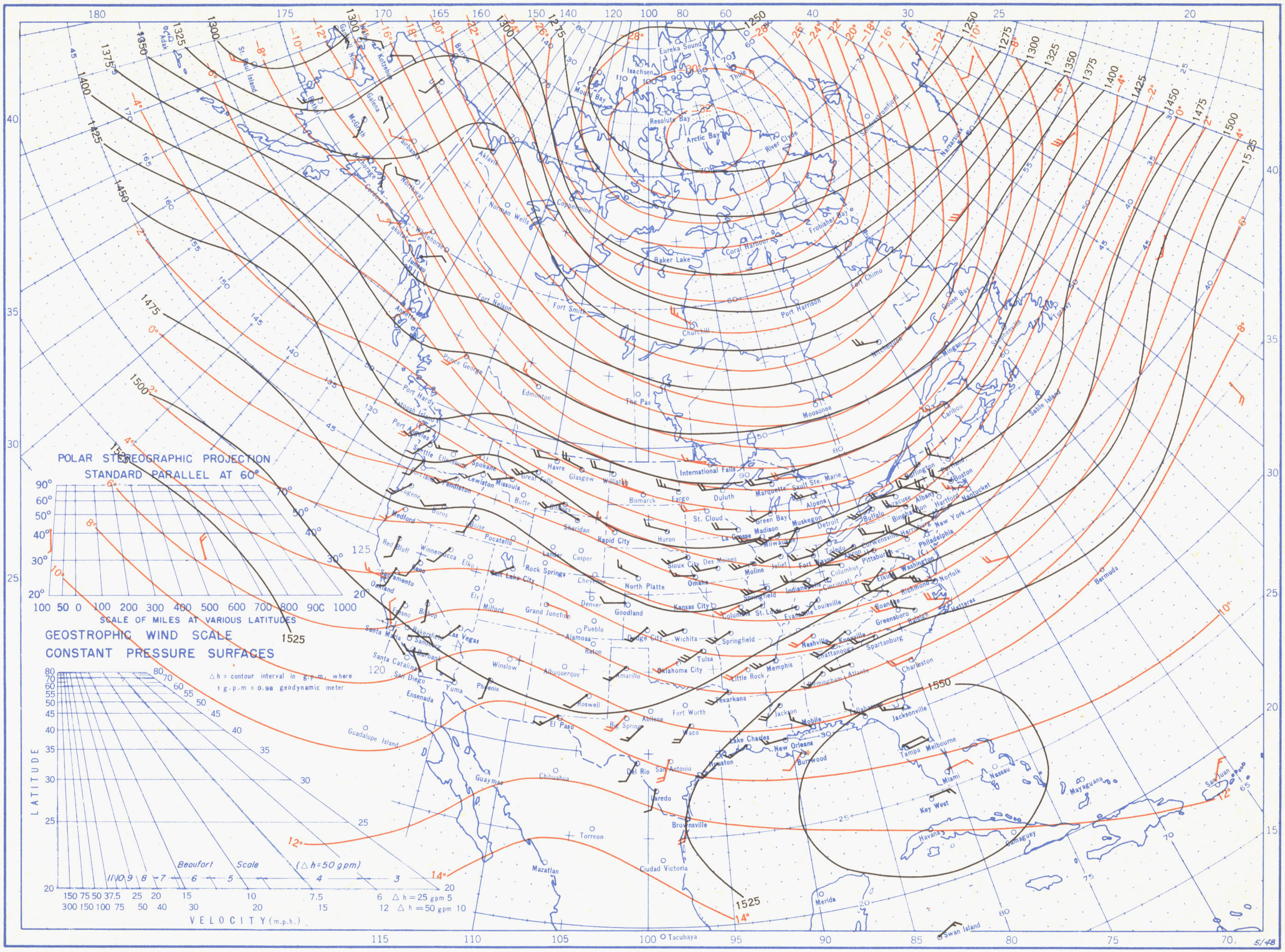
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, February 1951. Inset: Departure of Average Pressure (mb.) from Normal, February 1951.



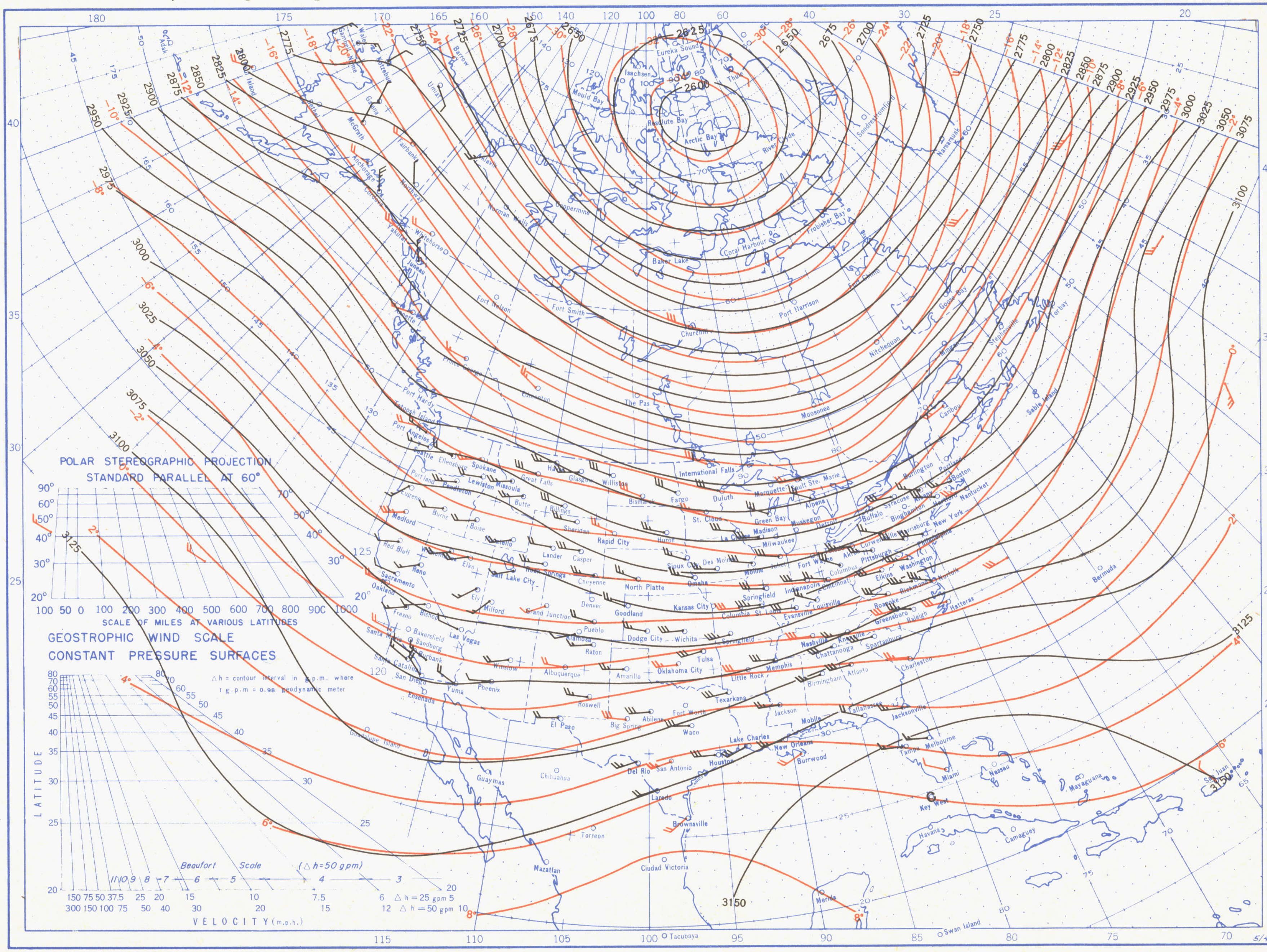
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid from map readings for 20 years of the Historical Weather Maps, 1899–1939.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), February 1951.



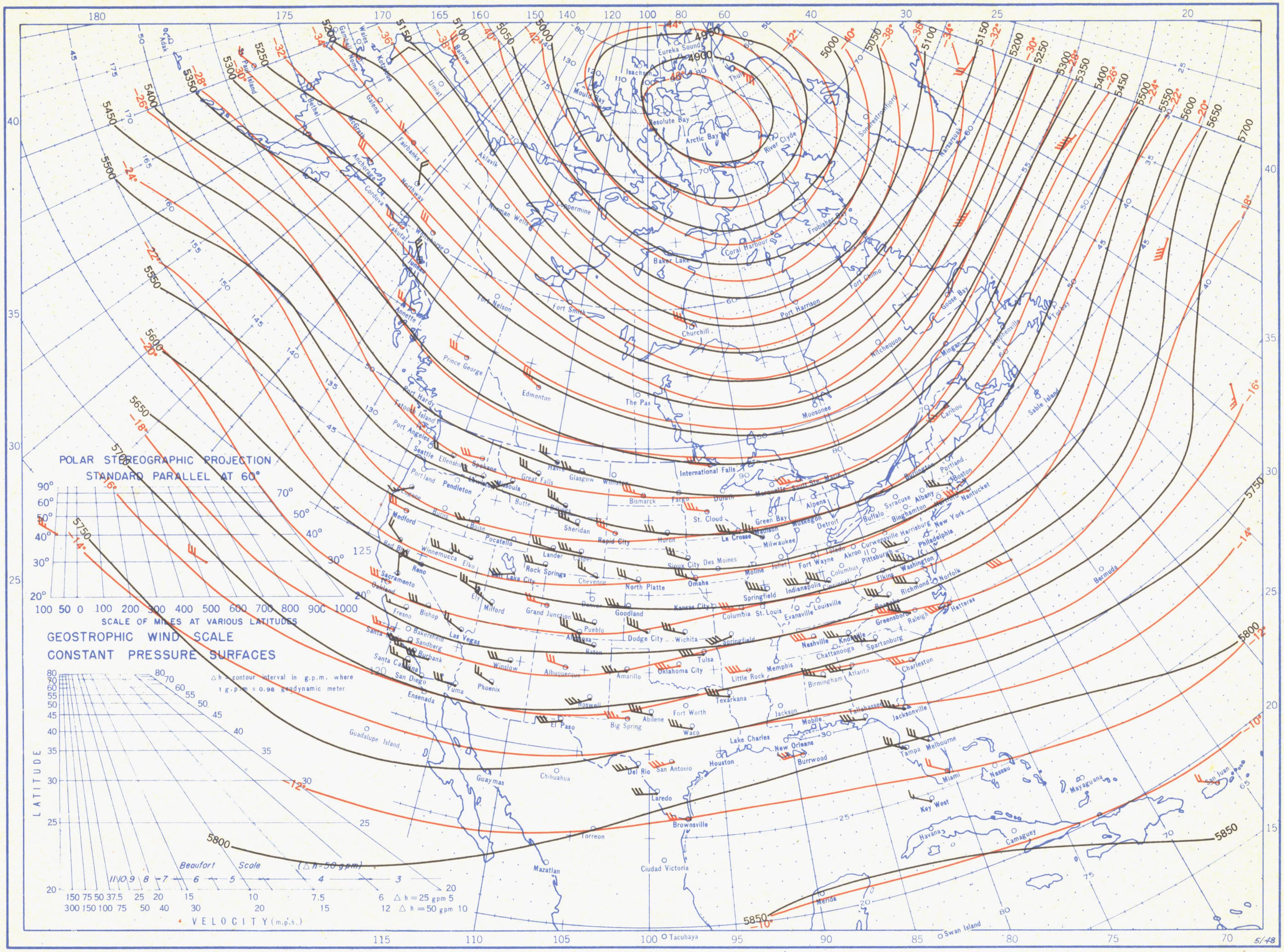
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m.. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.). February 1951.



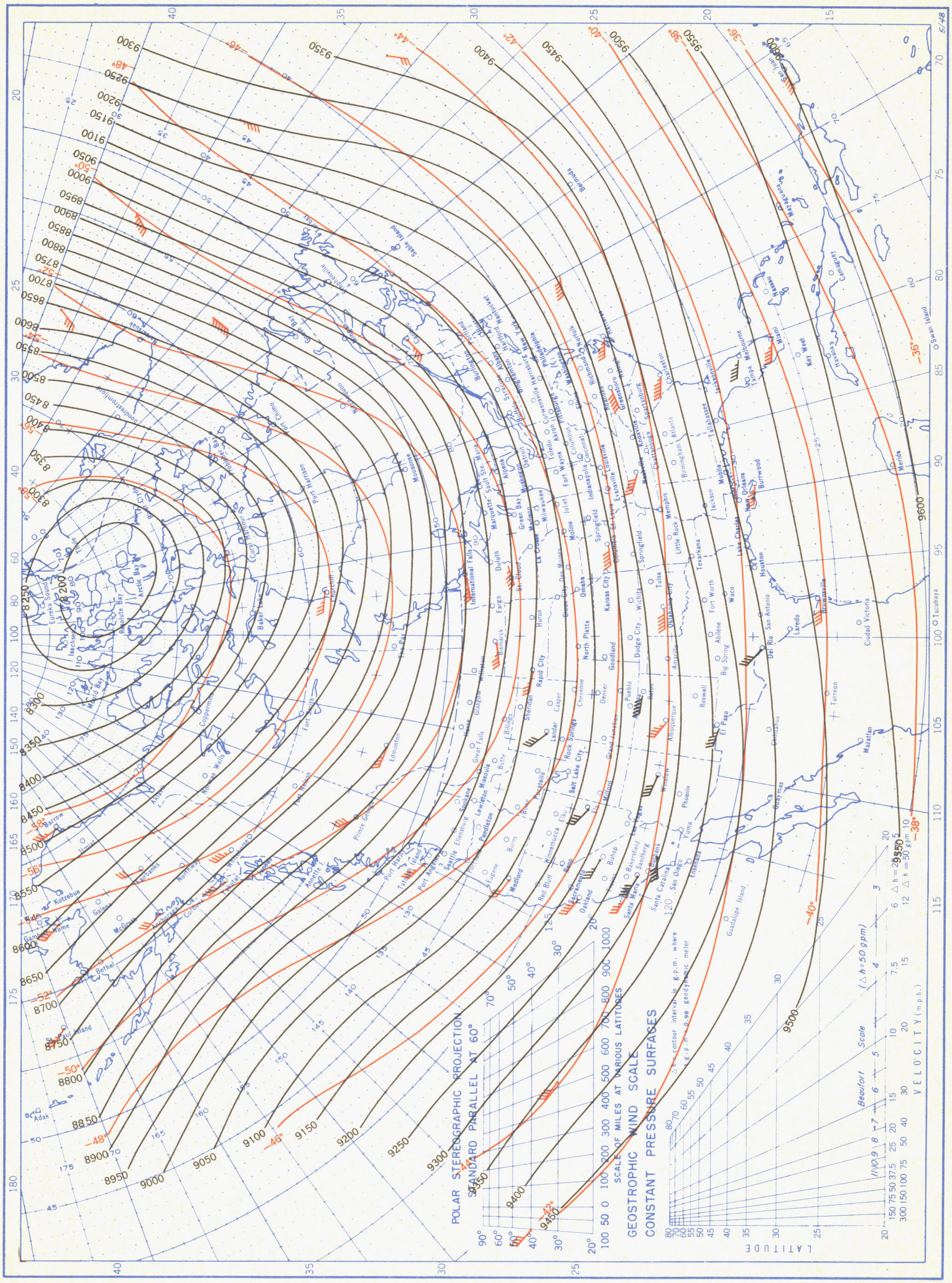
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), February 1951.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), February 1951.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.